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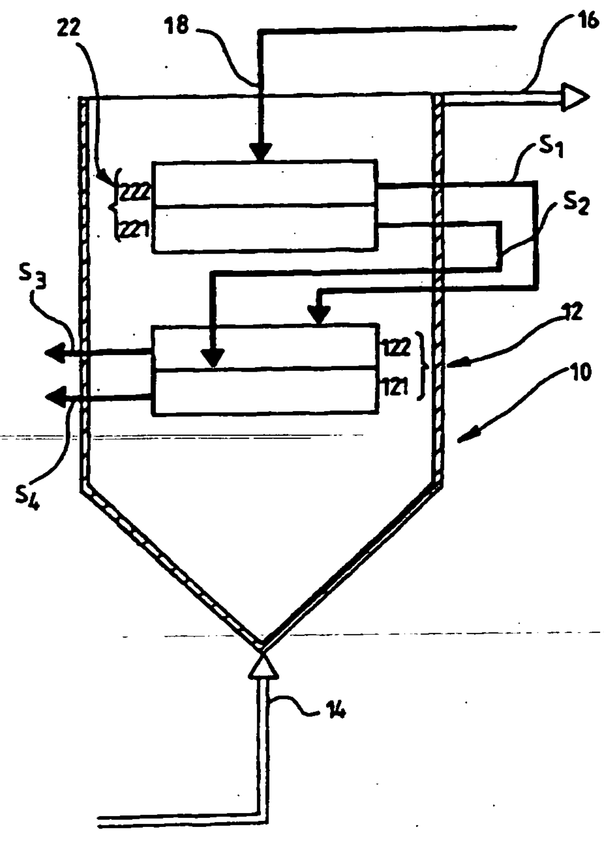
(57) Abstract

The present invention relates to a method of intensifying washing of pulp, especially in connection with oxygen delignification. The invention especially relates to the utilization of fractionating wash in oxygen delignification. The pulp is washed in at least two fractionating displacement washing stages (12, 22). Two different filtrate fractions (S1, S2) are removed from the second washing stage. These filtrates are used as washing liquids in the first washing stage (12). The temperature in the washing system is maintained above 90 °C and the thickness of the pulp layer to be washed is higher than 70 mm.



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WASHING OF PULP IN A FRACTIONATING WASHING SYSTEM

The present invention relates to a method of intensifying washing, especially in connection with oxygen delignification. The invention especially relates to the utilization of fractionating wash in connection with oxygen delignification.

Fractionating wash generally means that the filtrate is discharged from a washing stage at least in two fractions having different dry-solids contents. The filtrate divided in this way may be used in a suitable way in previous washing stages. The theory of fractionating wash has been described in a publication "A mathematical model of fractional pulp washing and applications in a bleach plant" by Tervola, Henricson, Gullichsen; Tappi Pulping Conference; Atlanta; November 1993, Book 1, pages 151 - 154. However, fractionating wash has been applied to practise only in plants employing the so-called DRUM DISPLACER® washers (a trade mark owned by A. Ahlstrom Corporation).

When efforts are made to wash pulp very clean and the emphasis is on the end stages of the washing process, the importance of sorption and extraction increases in the pulp wash. Thus, not only displacement but also displacement time becomes an important factor in the washing process. If necessary, extraction vessels may be provided between washing stages but they are not as important as the displacement time.

Conventionally, pulp has been washed after oxygen delignification either with two washers or two presses and a washing loss of 10 - 6 kg COD/ton of pulp has been reached (COD = Chemical Oxygen Demand, which indicates the amount of organic substance in effluents). As such, this is a good result but we have found out that changing the

washing system so as to take advantage of both the benefits provided by the fractionating washing arrangement and the influence of the displacement time reduces the washing loss further by 20 - 30 %. Simplified, it may be stated that the term "washing loss" used above describes in pulp production the volume of dry-solids ending up from the fibers to the effluent treatment. In other words, the reduction of the washing loss by 20 - 30 % results in a similar percentage in the reduction of environmental stress.

We have found out by tests that an advantageous way of providing a displacement time long enough is employing a washer in which the thickness of the pulp layer is adequate. Tests have proved that a suitable thickness is 70 - 400 mm, preferably 100 - 250 mm. Apparatus having conventionally this kind of pulp layer thicknesses are e.g. a continuous atmospheric diffuser employing a pulp layer thickness of 200 - 250 mm, and a pressure diffuser having a pulp layer thickness of 80 - 150 mm. The invention may thus be well applied to these washers but also to other washer types having an adequate pulp layer thickness. It should be noted that the above mentioned article discussing fractionating wash does not mention the use of extraction. An obvious reason for this is that the thickness of the pulp layer in a DRUM DISPLACER® washer is approx. 40 - 50 mm, which does not give a treatment time long enough for extracting dry-solids from the fibers.

A characteristic feature of the method of the invention is that the pulp layer to be washed is arranged thick enough for the extraction process.

A characteristic feature of a preferred embodiment of the invention is that

a) oxygen bleached pulp is conveyed to a washing system comprising at least two washing stages, at least two stages in the system having been divided into two zones;
b) pulp is washed in the first stage of said system by supplying different washing liquids to the zones of said stage and by extracting dry-solids from the pulp;
c) two washing filtrates are separated from the zones of said first stage;
d) pulp is washed in the second stage of said system by supplying washing liquids to the zones of said second stage and by extracting dry-solids from the pulp;
e) two washing filtrates are separated from the zones of said second stage, the filtrates being supplied as the washing liquids to stage b); and
f) the pulp is discharged from the washing system.

The method of the invention is described below by way of example more in detail with reference to the accompanying drawing figures of which

Fig. 1 illustrates schematically the method of the invention applied to an atmospheric diffuser;
Fig. 2 illustrates schematically the method of the invention applied to a wash following an oxygen delignification process;
Fig. 3 illustrates a horizontal and schematical cross-section of a conventional diffuser structure;
Figs. 4a and b illustrate a diffuser screen package in accordance with a preferred embodiment of the invention; and
Fig. 5 illustrates a preferred way of using the fractionating diffuser of the invention.

Fig. 1 illustrates an atmospheric diffuser 10, including two exemplary washing stages 12 and 22. The pulp to be washed is supplied to the bottom of the diffuser 10 via a conduit 14 and the washed pulp is discharged via a conduit

16 from the top of the vessel. When flowing upwards in the vessel the pulp is subjected to the first washing stage 12 and after that to the second washing stage 22; subsequently the washed pulp flows to the discharge conduit 16. Washing water is supplied via conduit 18 at the top of the vessel to the second washing stage 22 from which at least two filtrates, S1 and S2, are obtained by so-called fractionation, by dividing the washing stage into at least two zones 221 and 222, of which filtrates S2 is the first one (with regard to the flow direction of the pulp) and thus the more contaminated one while washing the more contaminated pulp. The filtrates S1 and S2 are taken to the first washing stage 12 as washing liquids so that the more contaminated first (in the flow direction of the pulp) washing liquid S2 is used in the first washing zone 121 and the cleaner washing liquid S1 is used in the second washing zone 122. Two "fresh" filtrates, S3 and S4, are obtained from the washing zones 121 and 122. Preferably, although not necessarily, the filtrates are conveyed from one washing stage to another by using the technical solutions disclosed in EP patent applications 92890090 and 92890253, where applicable.

By using the conventional connection of filtrate ducts used in diffusers, only one filtrate is obtained from each washing stage, in other words, the filtrates S1 and S2 as well as filtrates S3 and S4 are combined. We have studied the function of this kind of conventional connection and compared it with the function of the connection of the embodiment illustrated in Fig. 1 and found out that the volume of dissolved organic and inorganic substance originating from the process stages preceding the wash reduces by approx. 25 % with the connection according to our invention. The prerequisite, however, is that the displacement times in the washing stages 12 and 22 are long enough and that the washing proceeds far enough so that the extraction and sorption will have effect.

Fig. 2 illustrates an application according to the most preferred embodiment of the invention, i.e. providing, subsequent to an oxygen delignification stage, a diffuser employing fractionating wash. It has been discovered that in washing pulp after oxygen delignification, sorption and extraction phenomena are of great importance. In the embodiment of Fig. 2, pulp is prewashed in a washer 30, which preferably is a filter washer giving a discharged consistency of 10 - 18 %. After this the content of organic material dissolved from the fibers in the pulp is 140 - 160 kg/ton expressed as COD, preferably 100 - 80 kg COD/ton. In the oxygen delignification stage, pulp is supplied to one or several reactor/s 32 producing 10 - 50 kg COD/ton of organic material. From the reactor 32, pulp is conveyed to a washing system (in Fig. 2 an exemplary washing device similar to the one illustrated in Fig. 1 by reference number 10) comprising at least two washing stages utilizing fractionating wash and having a thickness of the pulp layer to be washed of 70 - 400 mm in order to ensure an adequate extraction time.

In the embodiment illustrated in Fig. 2, the washing system comprises a two-stage (12, 22) diffuser 10; naturally also a diffuser comprising more stages, or some other washing system meeting the basic requirements may be used. The filtrate connections of the diffuser 10 are similar to the ones in Fig. 1. The washing loss after a washing system described above is 7 - 4 kg COD/ton whereas with conventional methods it would have been 10 - 6 kg COD/ton of pulp.

In a preferred embodiment, fractionating wash is employed also in the washer 30 preceding the oxygen stage, which further improves the result. According to another preferred embodiment, also a thickener or a press 40 is provided after the diffuser 10 to increase the consistency to a range of 12 - 35 %, preferably to 15 - 25 %. This is

done because, since the washer 10 treats a thick layer of pulp, the discharge consistency is low, i.e. 8 - 12 %, which is often too low for the final bleaching.

It is advantageous to have a high temperature in the washer 10 to speed up the diffusion phenomena. An advantageous temperature is 70 - 120°C, preferably 80 - 100°C.

It is also favourable to connect the thickener 40 to the system in a fractionating way so that clean washing water W is brought to the second zone 222 of the washing stage 22 and the filtrate F from the thickener 40 is brought to the first washing zone 221 of the washing stage 22, as illustrated in Fig. 2.

When trying to minimize the amount of organic material in effluents, the clean washing liquid W is directed to serve as the washing liquid in the second zone 222 of the washing stage 22. Also, the filtrate F, which has been separated in the thickener 40 from the washed pulp having been discharged from the two- or multi-stage diffuser 10 following the oxygen stage, is used at least as a part of the washing liquid supplied to the first zone 221 of the second washing stage 22, while the rest of the liquid to the zone 221 may optionally but not necessarily be for example clean washing liquid W, as illustrated in the figure by a broken line. The two different filtrates S1 and S2 obtained from the washing stage 22 are directed to the first washing stage 12 so that the cleaner filtrate S1 flows to serve as the washing liquid in the second zone 122 of the first stage 12, and the more contaminated filtrate S2 to serve as the washing liquid in the first zone 121 of the washing stage 12. Separate filtrates, S3 which is the cleaner filtrate, and S4 which is the more contaminated one, are discharged from both the zones of the first washing stage 12, and conveyed to the washer 30

preceding the oxygen stage 32 to serve as the washing liquids. As the washer 30 is preferably a multi-stage filter-type washer, the filtrates/washing liquids produced by fractionation may be used also in this washer to wash the pulp to be supplied to the oxygen stage cleaner.

In Fig. 3, a horizontal and schematical cross-section of a conventional diffuser structure is shown. The diffuser 50 normally consists of a series of screen rings 52, 54 and 56 connected to arms 58. The washing liquid is introduced into the pulp from the top of the diffuser as shown in Fig 1. The washing liquid flows downwardly and flows further as a filtrate through the filter surfaces into the interior screen rings 52, 54, 56 and to the arms 58 via which it is, then, taken out of the system.

Figs. 4a and b illustrate a diffuser screen package in accordance with a preferred embodiment of the invention. For the sake of clarity the diffuser screen package 60 consisting of only one screen ring 62 is shown. Naturally it is clear that in practice a diffuser screen packace includes a number of coaxially arranged screen rings. The screen package 60 can be constructed for fractionating the filtrate flow by means of arranging a horizontal intermediate wall 64 into the interior volume of the screen ring 62 and fastened to the opposite filter surfaces 66 and 68. The intermediate wall 64 divides, preferably, the interior volume of the screen ring 62 into two equal volumes 70 and 72. The fractionated filtrate flows from said volumes 70, 72 are arranged my means of fastening a first set of arms 74 to the upper part of the screen ring 62 and a second set of arms 76 to the lower part of the screen ring 62. Arms 74 and 76 form a so-called piping systems for removing two different filtrate fractions from a washing stage.

Example

In an exemplifying case a fractionating two-stage diffuser was used after an oxygen reactor. The fractionated filtrates from the first washing stage were used in a washer prior to the oxygen delignification stage so that the more contaminated flow was used first. Compared to a conventional non-fractionated way of operating the system the following improvement was noticed:

softwood: total loss was reduced by 17 %, concentration in free liquid around fibers was reduced by about 29 %;

hardwood: total loss was reduced by 10 %, and concentration in free liquid around fibers was reduced by about 23 %.

The thickness of the fiber mat in the diffuser was 250 mm. The temperature was 90°C.

As may be understood from the above description, we have found ways to significantly reduce washing losses and thus to remarkably reduce the harmful environmental impact of the pulp industry.

Another way of using a fractionating diffuser 80 is its use in brown stock washing after a digester 82 (Fig. 5). The operational efficiency of the digester-diffuser combination may be improved by 10 - 20 % by taking the cleaner fraction 84 from the diffuser 80 to the bottom of the digester 82 and the more contaminated fraction 86 to a circulation in the digester 82, preferably to the wash circulation or the lowest circulation in the digester 82.

In this case also, the thickness of the fiber mat is 200 - 300 mm, the temperature being high, about 95°C.

Figure 5 shows yet another preferred embodiment of the present invention a system called "Extended cold blow system" for improving the washing performance. Strong wash liquid 86 is taken via a central pipe 88 to a point above the bottom of the digester 82. Weaker wash liquid 84 from the fractionating diffuser 80 is taken, possibly after cooling 90, to the bottom of the digester. Two liquids, 92 and 94, are extracted from the digester 82; namely, a strong liquid 92, strong in OH and S, suitable for chip pretreatment, and a weak liquid 94 for other purposes, like for example to evaporation or liquid fill. When cooking to low Kappa numbers, below 24 - 20, it is advantageous to use manhole screens in the extraction screen systems 96 and 98.

In the system illustrated in Fig. 5 the pulp thickness in the diffuser is 250 mm and in the digester bottom section 3 - 5 meters. The temperature in the diffuser is 95°C and in the digester bottom section 100 - 150°C.

As already indicated above, the use of an atmospheric diffuser illustrated in the figures is only one preferred embodiment of the invention. Also washers of other types and their combinations, which have been referred to in the appended patent claims by the term "washing system", may be used with certain preconditions set forth in the above description and the appended patent claims. It should also be noted that although the term "clean washing liquid" has been used, also a filtrate from some other process stage may be used as the washing liquid. For example, filtrates from alkaline oxygen and/or peroxide stages or acidic ozone, acidification or chelating stages may be used as the washing liquid as well as condensates or equivalent suitable liquids from other process stages. Further, it should be noted that the method of the invention may be applied for example to brown stock washing despite the fact that the above example deals with

a wash following an oxygen stage. Naturally, also other corresponding washer applications come into question.

Claims:

1. A method of treating pulp in a fractionating washing system comprising at least one fractionating displacement washing stage after the digestion of the pulp, **characterized** in the steps of
- washing the pulp in at least two fractionating displacement washing stages,
- providing said washing stages with fractionated filtrate flow between the washing stages,
- maintaining the temperature in the system above 90°C to allow efficient extraction, and
- maintaining the thickness of the pulp layer to be washed higher than 70 mm to allow sufficient time for extraction.

2. The method as recited in claim 1, **characterized** in washing the pulp in two stages, a first washing stage taking place in the bottom portion of the digester.

3. The method as recited in claim 1 or 2, **characterized** in washing the pulp in two stages, a second washing stage taking place in a fractionating diffuser.

4. The method as recited in claim 1, **characterized** in washing the pulp in two stages, both stages taking place in a fractionating diffuser.

5. The method as recited in claim 1 **characterized** in that each of said washing stages has been divided into at least two washing zones (121, 122; 221, 222) so that at least a first and a second washing filtrate fraction, S1 and S2, are extracted from at least the second washing stage (22), and that the second of said fractions, S2, is used as washing liquid prior to the first fraction, S1, in the first washing stage (12).

6. A method as claimed in claim 5, **characterized** in that the pulp washed in the washing system (10) is supplied to a thickener (40) in which the consistency of the pulp is raised to a range of 12 - 35 %.

7. A method as claimed in claim 5 or 6, **characterized** in that the pulp to the washing system (10) is brought from an oxygen delignification stage (32).

8. A method as claimed in claim 7, **characterized** in that the pulp to the oxygen delignification stage (32) is brought from a washer (30).

9. A method as claimed in claim 6, **characterized** in that the filtrate from the thickener (40) is directed to serve at least as a part of the washing liquid to be supplied to the second washing stage (22) of the washing system (10).

10. A method as claimed in claim 6, **characterized** in that the filtrate from the thickener (40) is directed to serve at least as a part of the washing liquid to be supplied to the first zone (221) of the second washing stage (22) of the washing system (10).

11. A method as claimed in claim 7, **characterized** in that two filtrates, S3 and S4, are extracted from the first washing stage (12) of the washing system (10), and directed countercurrently past the oxygen delignification stage (32) to the washer (30).

12. A method as claimed in claim 5, **characterized** in that the thickness of the pulp layer is 70 - 400 mm, preferably 100 - 250 mm.

13. A method as claimed in claim 5, **characterized** in that the temperature of the pulp in the wash is in the range 70 - 120 °C, preferably 80 - 100 °C.

14. A method as claimed in claim 5, **characterized** in that said washing system (10) is an atmospheric or a pressurized diffuser.

15. A method as claimed in claim 7, **characterized** in, for reducing wash losses in oxygen delignification, extracting dry solids from the pulp in the washing stages.

16. A method as claimed in claim 1 and 5, **characterized** in discharging the pulp from the washing stages to a thickener, in which liquid is removed from the pulp, and the liquid is brought to the first washing zone of the second washing stage to serve as the washing liquid.

17. A system for washing the pulp after digesting said washing system comprising at least two washing stages, i.e. at least a first washing stage and a second washing stage, said second washing stage having at least one circular reciprocally moving screen surface (60; 66, 68) for extracting filtrate from pulp into a filtrate volume behind said screen surface (60; 66, 68), **characterized** in an intermediate wall (64) in said filtrate volume dividing said filtrate volume into an upper and a lower section (70, 72); said upper and lower sections (70, 72) of said filtrate volume being connected to separate piping systems (74, 76) for removing two different filtrate fractions from said second washing stage, said two different filtrate fractions being taken to said first washing stage having separate injection points for the two filtrate fractions.

18. The system as recited in claim 17, **characterized** in that said washing system comprises at least one diffuser (80).

19. The system as recited in claim 17, **characterized** in that said second washing stage is performed in a diffuser

(80) and said first washing stage is performed in a bottom part of a digester (82).

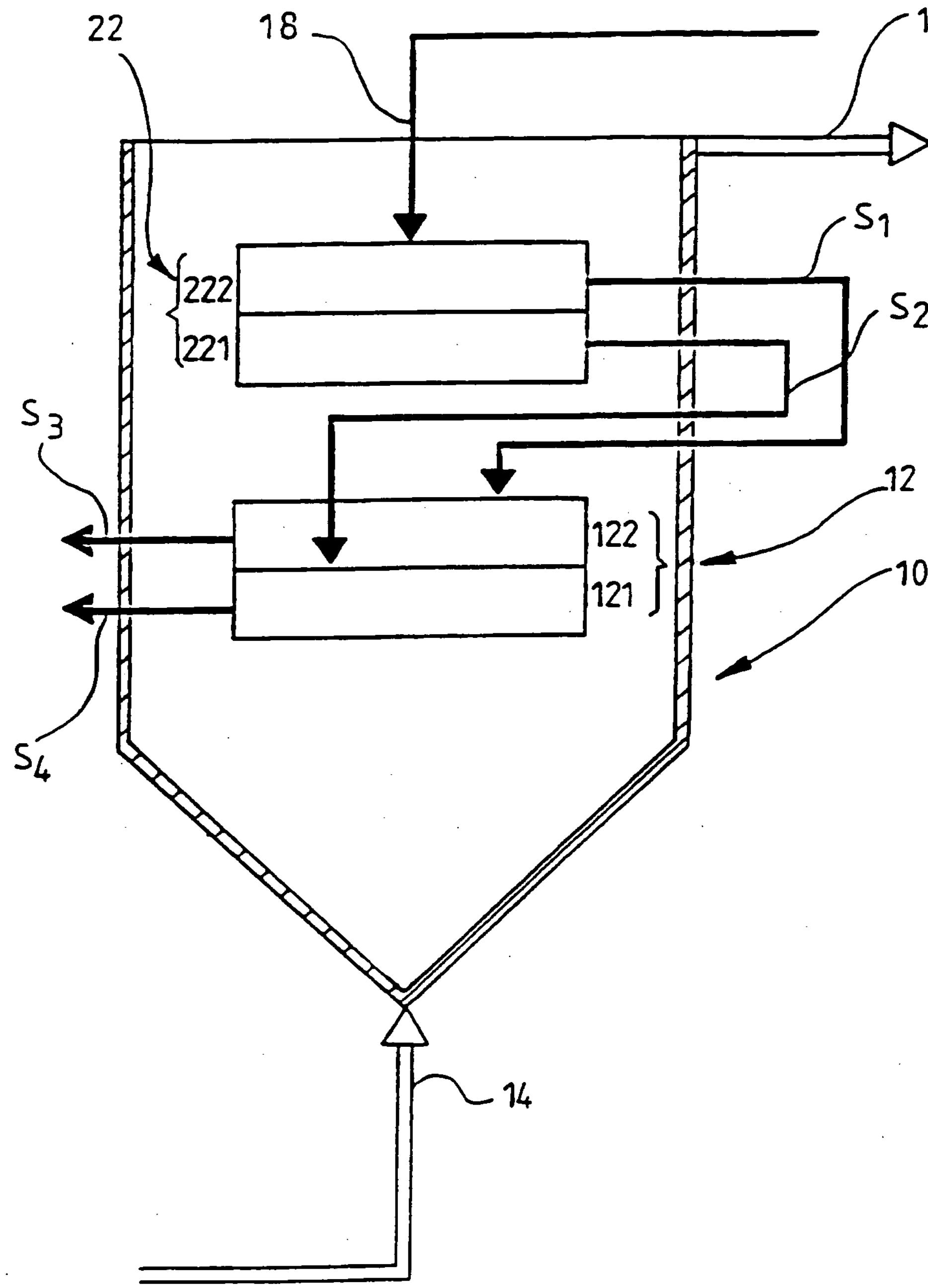

FIG. 1

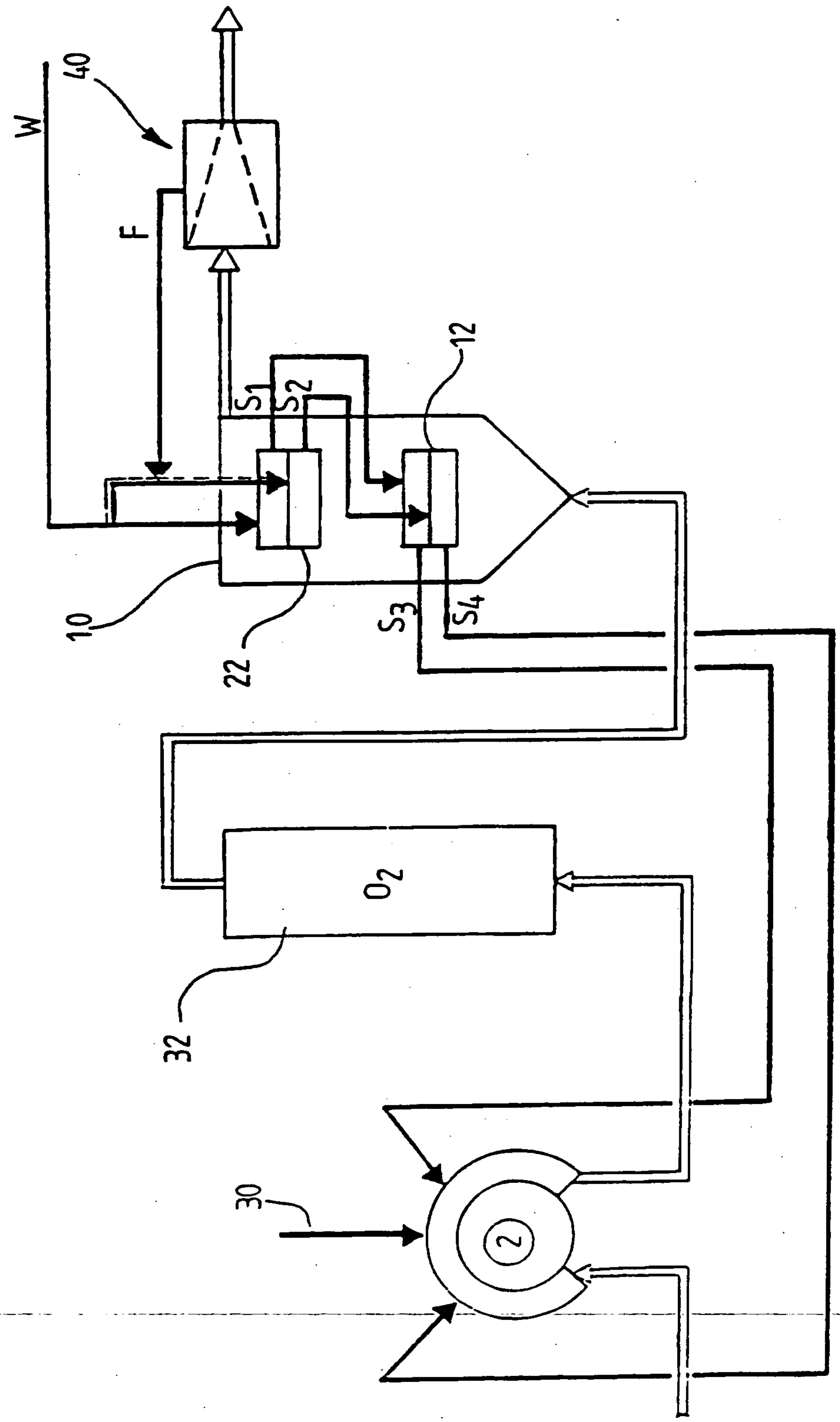

FIG.2

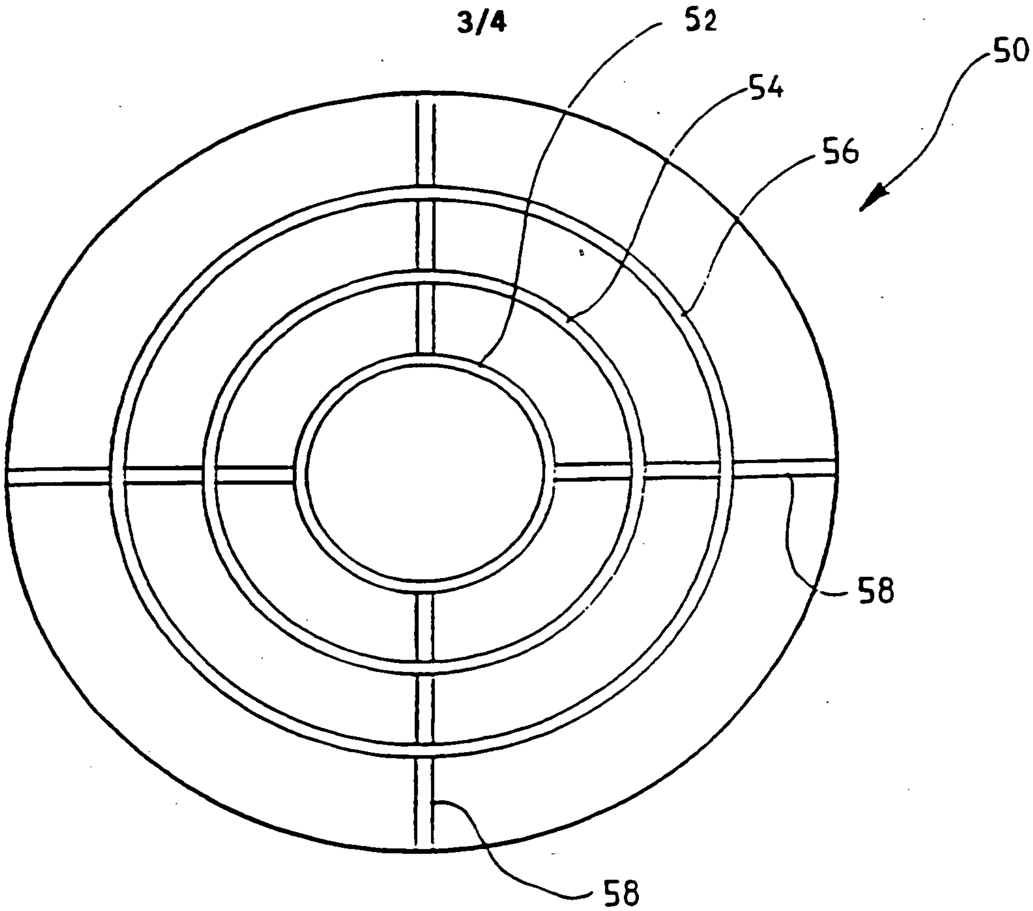

FIG. 3

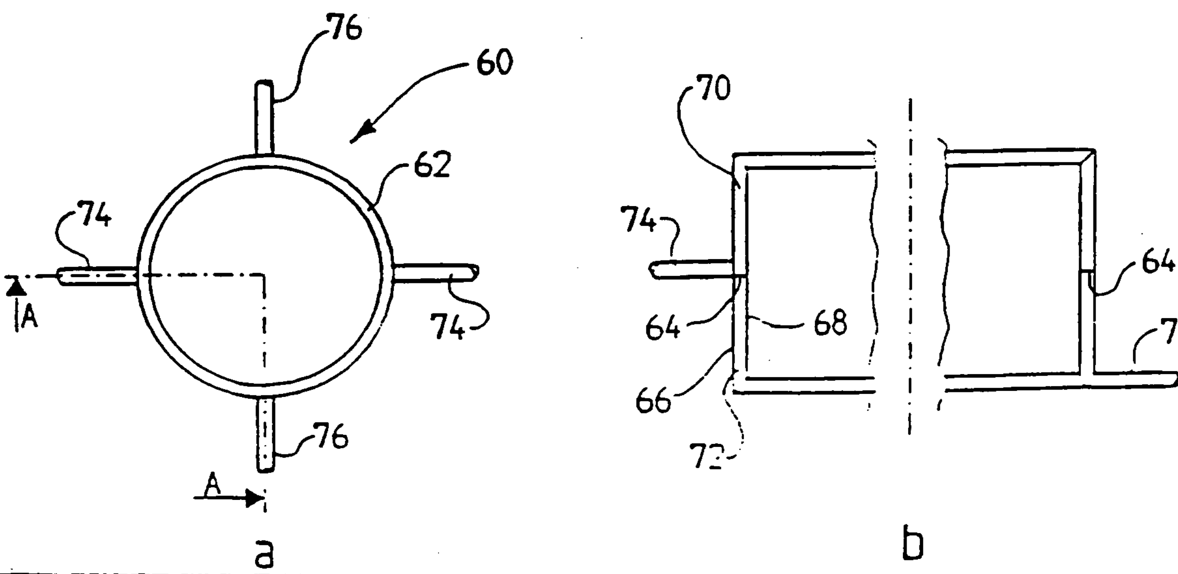

FIG. 4

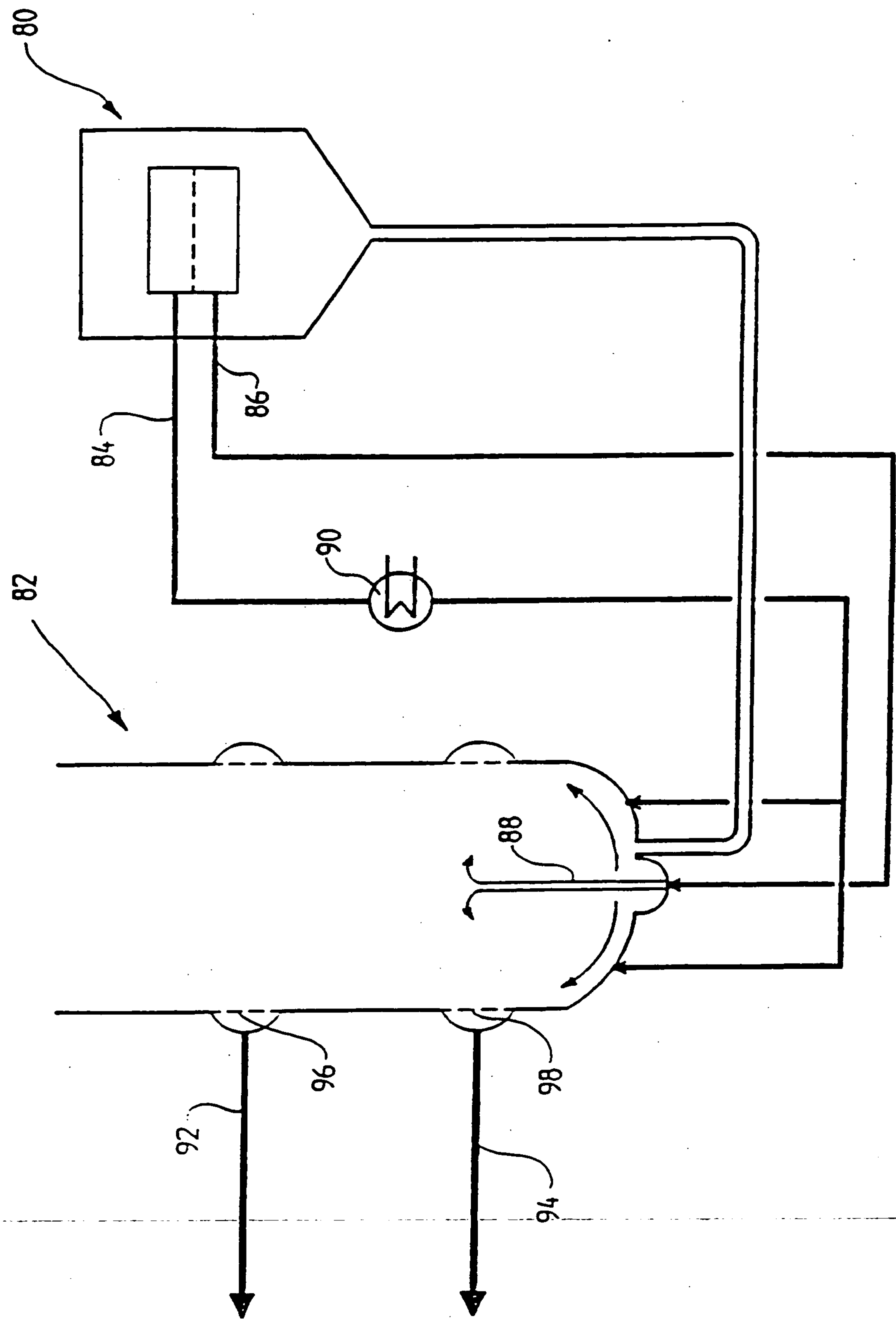

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 95/00668

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: D21C 9/02, D21C 9/04, D21D 1/40
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	TAPPI Pulping Conference, Book 1, 1993, Atlanta Georgia, Tappi press, P. Tervola et al: "A mathematical model of fractional pulp washing and applications in a bleach plant", page 151 - page 154, see page 153 and figure 6 --	1-19
A	US 4971658 A (KAJ HENRICSON ET AL), 20 November 1990 (20.11.90), figure 5 --	1-19
A	Tvättning av massa, Y-206 1- 2000.1974.07, ISBN 91-7322-014-0, Sveriges Skogsindustriförbund, 1974, page 10, line 16 - line 29; page 26, line 11 - line 18; page 30; page 32, line 14 - line 18; page 33 --	1-19

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 95/00668

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0509981 A1 (KAMYR, INC.), 21 October 1992 (21.10.92), figure 1, claim 1	1-19

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INTERNATIONAL SEARCH REPORT
Information on patent family members

01/04/96

International application No.
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